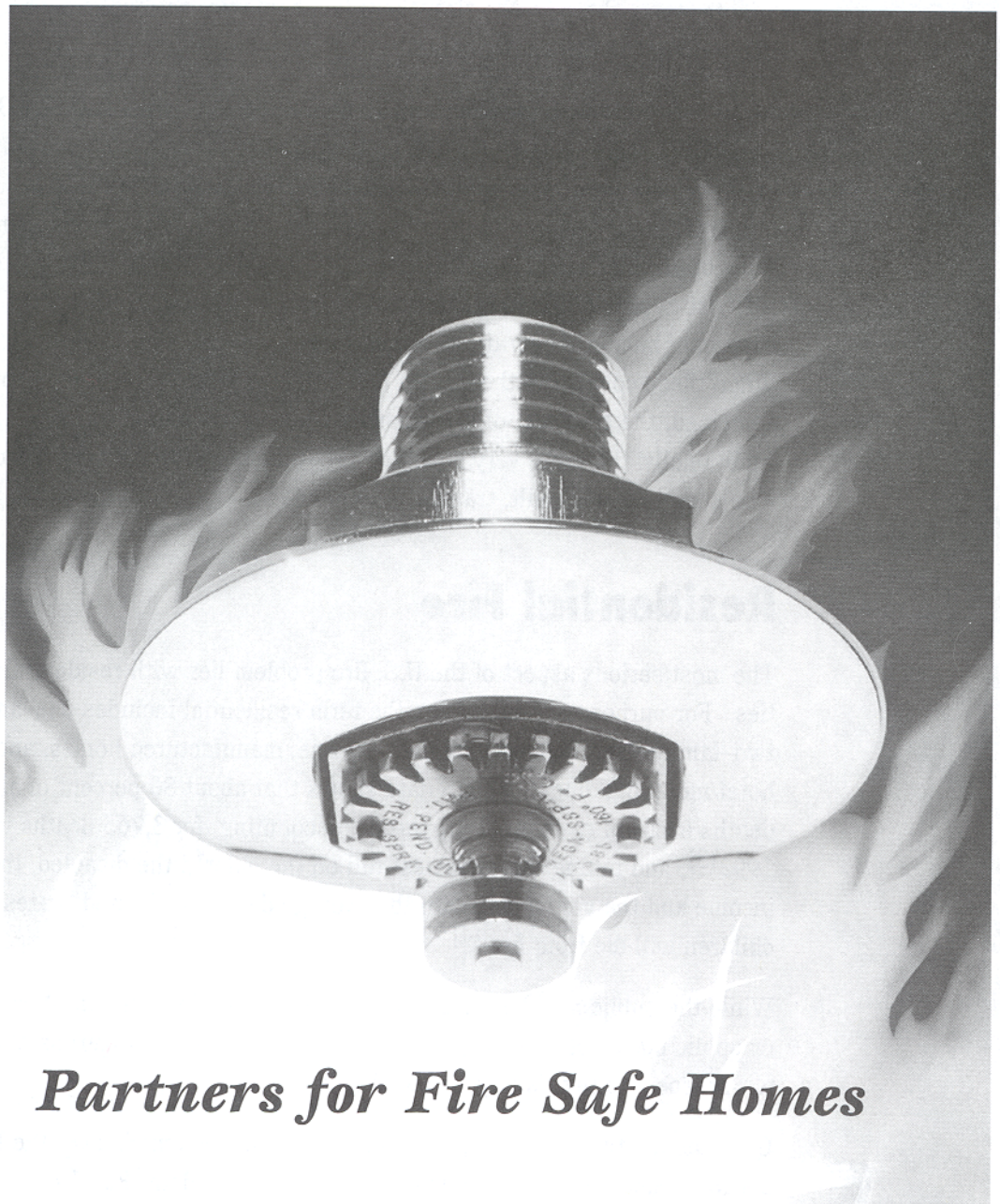
Reducing America's Fire Losses **with Residential Fire Sprinkler Systems**



Partners for Fire Safe Homes

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OFFICE OF STATE FIRE MARSHAL

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United States Fire Administration

Background

The Fire Problem in the United States

The United States has a serious and substantial fire problem. Roughly once every one and one–half seconds an unreported fire occurs. Nearly once every minute, somewhere in America, there is a home fire serious enough to warrant calling the fire department.(1)

All told, fire in the United States kills more people – more than 4,500 in 1993 – than all natural disasters, such as floods, hurricanes, tornadoes, earthquakes and blizzards, combined. The rate of death from fire in the U.S. is significantly higher than in other industrialized nations. The economic implications of fire loss are staggering – such as the cost of built-in fire protection, the cost of providing fire insurance, the cost of fire fighting services, the disruption of business operations after fire, medical costs for those injured, etc. When these costs, and the human and property losses directly due to fire are combined, the true cost of fire pushes up past $100 billion a year(2). Additionally, there are very substantial psychological impacts of fire on those who survive: grief, guilt, trauma from injury.

Residential Fire

The most serious aspect of the U.S. fire problem lies with residential properties. For purposes of this paper, the term residential includes one–and two–family, multi–family high and low rise, manufactured homes, and hotel/motel buildings. NFIRS data shows that about 80 percent of all fire deaths occur in residential properties, accounting for 3,765 deaths in 1992(3), and taking their heaviest toll on the elderly, the disabled, the low income and the very young. On the average day in the United States, four children will die from fire.(4)

While the public may hear more about the spectacular fires, in office buildings or public places of assembly, the truth is that the most dangerous place to be, with respect to fire, is in your own home.

Grim though this picture is, improvements have been made over the last two decades. Since the mid–70s, when the landmark Federal Fire Prevention and Control Act was passed, fire officials at local, state and Federal levels, as well as private sector leaders, have mounted a significant attack on America's fire problem.

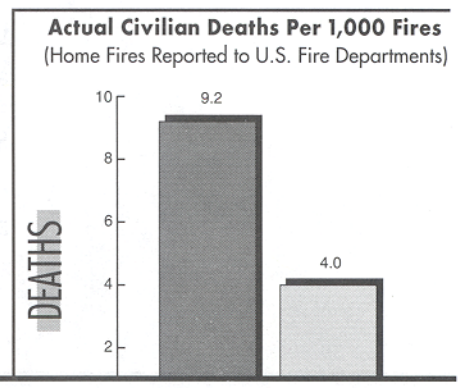
Improvements in fire death rates have come from several different approaches. Fire departments today are better equipped and better trained than they were 20 years ago. Public education and awareness programs have made people more aware of fire danger. Lifestyle changes, like fewer people smoking, have made a significant impact. Improvements in home heating and building materials have reduced some threats. Further, building code changes have reduced the risk of fire in houses.

But far and away the most potent weapon in fighting fire death has been the smoke detector.

The Impact of Smoke Detectors

In the 1960s, the average U.S. citizen had never heard of a smoke detector. By 1993, an estimated 92 percent of all American homes – single– and multi–family, apartments, nursing homes, dormitories, etc. – were equipped with detectors.(5) By the mid 1980s, smoke detector laws, requiring that detectors be placed in all new and existing residences – existed in 38 states and thousands of municipalities nationwide.(6) And smoke detector provisions have been adopted by all of the model building code organizations.

Fire services across the country have played a major and influential public education role in alerting the public to the benefits of smoke detectors. Another key factor in this huge and rapid penetration of both the marketplace and the builder community has been the development and marketing of low cost detectors by commercial companies. In the early 1970s, the cost of protecting a three bedroom home with professionally installed detectors was approximately $1000(7); today the cost of owner–installed detectors in the same house has come home down to as little as $10 per detector, or less than $50 for the entire home. This cost structure, combined with effective public education (including key private–public partnerships), has caused a huge percentage of America's consumers, whether they are renting or buying, to demand smoke detector protection. The impact of smoke detectors on fire safety and protection is dramatic and can be simply stated. When fire breaks out, the smoke detector, functioning as an early warning system, reduces the risk of dying by nearly 50 percent. Detectors are most people's first line of defense against fire.



Looking Beyond Smoke Detectors

Smoke detectors have proven their importance in homes, but fire experts across the country are beginning to see their limitations as the only intervention strategy. First, there is mounting concern about maintenance: it is reported that in one–fifth of all houses with detectors, those detectors are not operational[8]. This is principally because owners don't replace batteries in battery–operated detectors. Second, many homes are inadequately protected – often with only one detector when two or more are needed.

This is especially true for larger homes.[9] Third, it is increasingly clear that smoke detectors "won't last forever" and that detectors should be replaced every 10 years.

One door–to–door survey in Connecticut found that 39 percent of all dwellings needed additional detectors.[10] As important, the 8 percent of occupancies that don't have detectors are the ones most likely to have fires.[11] In fact, they have nearly half the home fires and a much larger share of fire deaths. Most fire deaths take place in residences without working detectors.[12]

Additionally, smoke detectors – which clearly do save lives when properly installed and maintained – have had less dramatic impact on either property loss or the cost of fire service.[13] With a properly installed and working smoke detector, occupants are provided early warning. However, unless residents are able to extinguish a small fire, the blaze continues. The fire department must expend the resources to fight the fire.

Therefore, many fire officials, faced with increasing pressure on municipal budgets as well as high fire loss statistics, are coming to the conclusion that smoke detectors alone are not the answer to the country's residential fire problem.

Everyone agrees that smoke detector usage must be maintained and extended. But to achieve further meaningful progress in fire protection and safety, we also need an additional intervention. That intervention – already available to us – is wide scale installation of the fast response residential fire sprinkler system.

Sprinklers have been used in industrial buildings for many years, and in the last 25 years have become increasingly required for both new commercial construction and renovation. Originally introduced as a property protection

device, sprinklers are now seen clearly as a way to save lives, protect property and help control against increases in the future cost of fire service and protection as well.[14]

These benefits, transferred to the residential sector, could clearly achieve a dramatic advance in fire protection and life safety.

Smoke detectors do what their name implies. They provide early detection, and thus warning, of the fire. But they take no action on the fire itself.

The Case for Residential Sprinklers

Residential sprinklers represent a different approach and technology. They add fire suppression to the early warning of smoke detectors. First, a heat sensitive element – called the fusible link – detects the heat from fires. Second, the sprinkler releases water on the fire, extinguishing the fires or confining the fire until the fire department arrives. It is the ability of sprinkler systems to control or extinguish fires in their early stages that makes them such a critical tool in fire protection strategy.

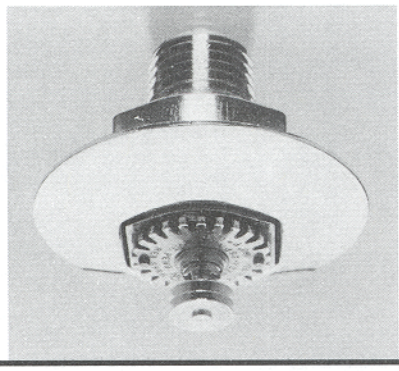
Each sprinkler head responds independently, so that when heat is detected and the sprinkler goes off – which is referred to as "activation" – it puts water only on the affected area and not throughout the rest of the house or building. In roughly 90 percent of all documented sprinkler activations in residences, one sprinkler has been sufficient to control the fire.(15)

The Appeal of Sprinkler Systems

The cost of sprinklers is significant compared to smoke detector costs. But the appeal of sprinklers is also significantly greater, for several basic reasons:

• Sprinklers offer a package of protection that is far broader than what can be achieved by other interventions. With sprinklers, the homeowners are protecting not only lives, but also the property, the furnishings, and all the intangibles of residential security and peace of mind.

• Sprinklers achieve these benefits with proven automatic technology. Like other state–of–the–art automatic restraint systems (e.g. airbags), they do not rely on changed human behavior to prevent accidents and loss. The vast majority of all residential fires today are estimated to have behavioral causes – like careless smoking, unattended cooking or children playing with fire. While we cannot design adults to never smoke carelessly or all children to not hide in the closet after they have accidentally set a fire, we can design sprinkler systems to control the results of this behavior.



• Sprinklers offer opportunities for more effective use of fire and emergency service resources. Sprinklers systems do not necessarily reduce the number of calls for firefighters, but they do reduce the severity of the fire, thereby reducing danger to firefighters and complexity of response. And because sprinklers could diminish the requirements of fire suppression, they also make it possible for the fire service to allocate more resources to important Emergency Medical Service (EMS) demands, search and rescue needs, etc.[16]

Sprinkler Experience to Date

Ten years ago there was little experience with how sprinklers – if they were installed in significant numbers of residential dwellings – would affect the nationwide fire problem. Fortunately, we are now beginning to build a significant body of experience in various locations across the country.

Much of this work has been supported by the United States Fire Administration (USFA) as part of a concerted public and private sector effort to determine the appropriate role of residential sprinklers in the country's overall fire suppression and protection strategy. Some of the most extensive experience with residential sprinklers is reflected in the following locations or projects:

> ***"The fire problem in this country is not concrete, it is not the construction of the building, it is not the age of the building, it's not whether it's old or new — the problem is threefold: men, women and children — that's what the real problem is."***
>
> **Chief Dave Hilton (Retired)**
> **Director, Cobb County GA**
> **Department of Fire & Emergency Services**

■ San Clemente, California in 1978, was the Nation's first jurisdiction to require residential fire sprinklers in all new properties.

■ Operation San Francisco, which in the early 1980s served as a national pilot project for residential sprinkler application and testing.

■ Operation Life Safety, a public/private consortium that, among other activities, monitors residential sprinkler activations all across the country, and tracks the human and property loss statistics for each of those activations.

■ Cobb County, Georgia, which has tested voluntary incentives, resulting in reduced construction costs, for builders who install sprinklers in new multi–family housing.

■ Napa, California, where a series of ordinances now require automatic sprinkler protection for a variety of new single and multi–family residences, including all new homes built more than 1.5 miles from a fire station.

■ Prince George's County, Maryland, which has required automatic fire sprinklers for all new residential construction, including single family dwellings, since 1987.

■ Scottsdale, Arizona, which passed the nation's most comprehensive sprinkler ordinance in 1985, requiring an automatic sprinkler system in every room of every new industrial, commercial or residential building in the city.

■ Several "retrofit" demonstration projects, supported by USFA and the National Association of Home Builders Research Center(NAHB–RC), to design and install sprinklers in low income single and multi–family housing units undergoing rehabilitation in a number of U.S. cities.

■ A self–contained, limited water supply sprinkler research and development project of USFA targeting mobile home fire safety.

■ Several demonstration projects, supported by USFA and NAHB–RC to identify barriers to residential sprinklers and solutions to these problems.

■ Port Angeles, Washington has been requiring sprinklers since 1986 in all newly constructed multi-family residential properties. They have also implemented a combination residential sprinkler system program reducing the cost of sprinkler installation by 30%. Subdivisions four minutes from a fire station are required to be sprinklered.

The Major Conclusions for Experience with Sprinklers

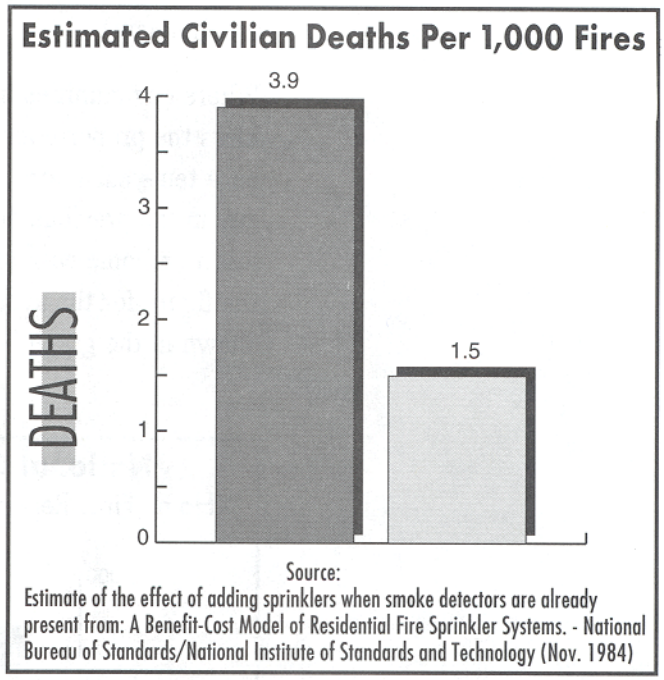
It is possible to draw a number of important conclusions about residential sprinklers from the projects and experience just listed. Most significantly:

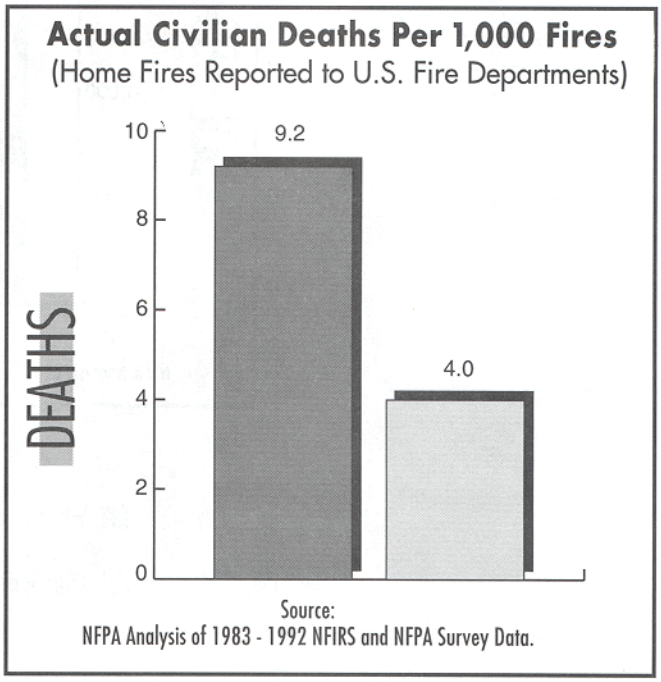
1. Residential Sprinklers Save Lives

The evidence on this point is overwhelming. There has not been a single residential fire fatality in a residence with a sprinkler system in either Napa, California or Cobb County, Georgia since the inception of those programs. There has not been a single fire fatality in Prince George's County, Maryland in a building with a sprinkler system. Scottsdale, Arizona credits sprinkler systems with saving up to 52 lives since the ordinance passed in 1985.

A 1984 report by the Bureau of Standards/National Institute of Standards and Technology estimated that the effect of adding fire sprinklers when smoke detectors are already present could reduce the number of fire fatalities by 63 percent. (As shown in the top graph on the right.)

A NFPA analysis of national data, collected from 1983 to 1992, indicates the number of fire deaths per 1,000 fires was reduced by 57 percent in homes with sprinklers. (As shown in the bottom graph on the right.)





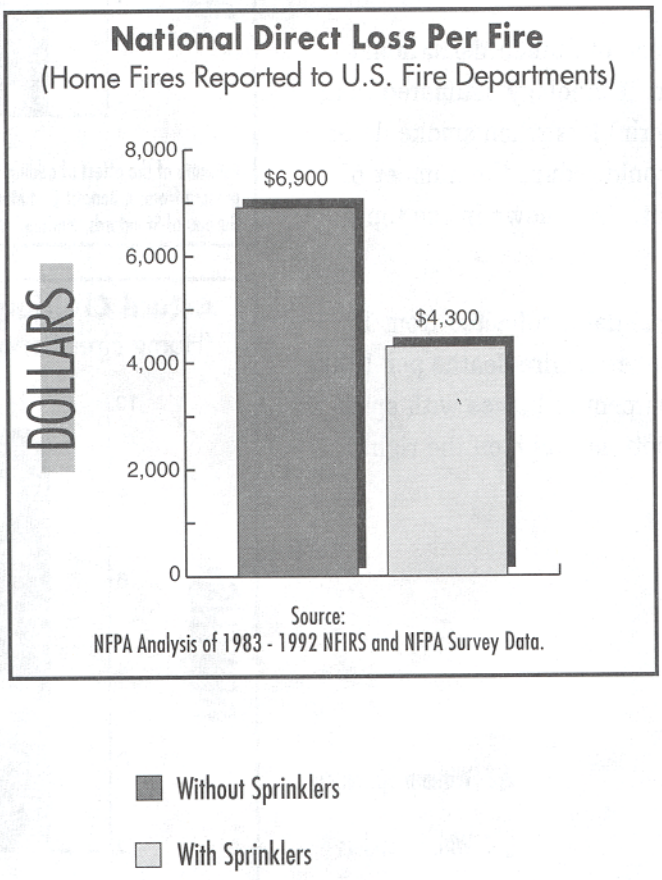
Without Sprinklers

With Sprinklers

2. *Residential Sprinklers Reduce Property Loss*

Again, the evidence is dramatic. Cobb County, Georgia and Napa, California reported minimal or incidental damage for all of their sprinkler activations, against potential losses extending into the millions, especially for Cobb's multi–family units. Nationally, average property loss in homes with sprinklers is 38% lower than homes without sprinklers, according to a NFPA survey of home fires reported to fire departments from 1983 – 1992. (As shown in the graph below.)

Where communities have a great deal of experience with residential fire sprinklers the property loss reduction can be much higher. In Scottsdale, fire loss hit a ten–year low in 1992, despite nearly 30 percent population growth in the city in the previous decade. Scottsdale's tracking data show that the average loss in a home with sprinklers in the city, since 1985, has been $1,382, while the figure for the average loss in a house without sprinklers is $3,928. (As shown in the graph below.)



3. Residential Sprinklers Costs Can Be Substantially Reduced and Offset

Builders are understandably reluctant to add to the cost of new construction, especially in a tough economy and at a time when there is already concern that large numbers of Americans are priced out of the new housing market.

Important research is underway to advance the technology, reduce the cost and identify ways to overcome barriers to widespread use. There is increasing evidence that innovations like combining the sprinkler system with the in–home plumbing system, streamlining of the design and permit process, acceptance of building code alternatives and new ideas in site plans for subdivisions can change the economics of sprinkler decisions.

Building code alternatives that communities can consider include: reduction in fire rated gypsum wall board requirements, alterations to attic fire stops, and reduced fire retardant standards for both masonry walls and doors. Cobb County, GA, is a national leader in building code alternatives, particularly for multi–family units.

More widespread is the use of alternatives in site plans for subdivisions that use residential fire sprinklers. Variations in length of set back, density of housing units, street width, turn around radius in cul–de–sacs, water main size and distance between fire hydrants, among others, produce cost savings for builders.

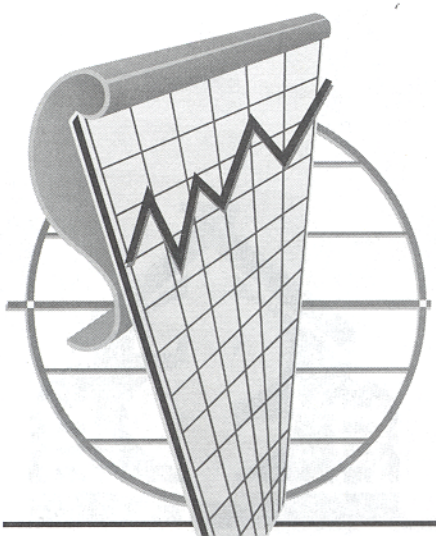
The United States Fire Administration is sponsoring a program with the National Association of Home Builders Research Center and the International City Management Association to identify barriers to residential fire sprinklers and test alternatives. They have developed and are testing a guide to simplify residential fire sprinkler system design and engineering and are working with combined domestic water and sprinkler system installations. In Cedar Rapids, IA, demonstrations, using the guide and a combined system, wholesale costs have dropped under 50 cents per square foot. In their Prince George's County, MD, work, and in eight other sites, the guide has dropped costs to about 80 cents per square foot. Combined systems are expected to reduce these costs further.

4. Over Time, Residential Sprinklers Will Slow Increases in the Cost of Fire Protection and Allow the Fire Service to Put More Emphasis on Other Pressing Emergency Resource Needs

Systematic studies of the comparative cost of fire service operation with and without residential sprinklers have not yet been done on a national basis, but individual community experience establishes a clear trend, especially in communities where rapid population growth would otherwise require significant expansion of the fire service. Several high–growth California communities report reduced growth of fire department costs, without any reduction in level of service. Former San Clemente Fire Chief Ron Coleman – who is now the California State Fire Marshal – recently noted how his service "used sprinklers as a means of controlling the fire problem without enormous increases in fire stations, equipment and manpower, as the communities were being built up."

Similar trends are reported for Scottsdale, Arizona, which grew by nearly 30 percent in the seven years after passage of the sprinkler ordinance. Today, Scottsdale citizens pay 30 – 50 percent less for fire services than residents in surrounding communities. But at the same time, according to Scottsdale officials, the city's Rural/Metro fire service is able to employ more than 50 percent more fire prevention personnel than the regional average.[17] These individuals spend their time in public fire education, building inspection, plan review, arson investigation, and fire prevention administration. This reallocation of available resources, to growing EMS demands or to other basic public services (education or police for example) can be a significant benefit to localities across the country.

5. Residential Sprinklers Have Potential to Reduce Homeowner and Property Insurance Costs



At the present time, insurance reductions are much more common for multi–family units with sprinklers, or for institutional kinds of residential properties – nursing homes, dormitories, etc. – than they are for single family units. Owners of four of the five multi– family units involved in the USFA

sprinkler retrofit project received reduction in insurance premiums, for example, after installation of sprinklers. The rate of reduction ranged from 4–40 percent.[18] In the one and two family unit market, reductions occur, but thus far the timetable for action is longer and the percentages of reduction less dramatic. Collectively, more work is necessary to encourage the insurance industry to carry long–standing commercial insurance discounts for sprinkler systems to the residential market.

In general, the Insurance Service Office (ISO) recommends a 13 percent discount for a one or two family residential sprinkler system meeting NFPA 13D standards – with 2 percent more if smoke detectors are also present. This is from the total premium, not just the fire portion.[19]

The evidence from communities that have led the way with voluntary sprinkler programs or ordinances suggests that benefits to date are substantial, for both saved lives and saved property. The evidence further suggests that down–the–road benefits, in terms of reduced construction and insurance costs, and greater control of future fire service cost increases, will also be substantial.

Protecting Lives and Property with Residential Sprinklers: Where are We Today?

1. The incidence of residential sprinklers nation–wide is extremely low.

Today, residential sprinklers are probably found in fewer than one percent of all one and two family housing units. The nationwide figure for multi–family units, while believed to be greater, is probably less than 10 percent. Incidence of residential sprinklers in communities with ordinances and voluntary programs run considerably higher – Prince George's County in Maryland estimates that 20 percent of all multi–family units, and 4 percent of one and two family units, now have sprinkler systems, for example. But nationwide, the penetration numbers are very low, especially if existing housing stock, as opposed to new, is considered.

2. A substantial amount of the research and demonstration work, to develop the technology for quick, reliable, and affordable sprinklers, has been completed.

USFA–supported research in the last 15 years has produced significant technological gain. The basic technology has been made to activate much faster (sprinklers now exist for residential use that have a response time five times faster than commercial sprinklers). Sprinklers have been adapted to meet the particular requirements of virtually every kind of residential housing. Sprinklers are no longer unattractive (in the sense of being less obtrusive to the homeowner). Sprinklers are increasingly less demanding in terms of water flow – in many instances they operate off the domestic water supply and do not require any special lines or pumps. Low water volume units with self–contained water supplies have been developed to meet the particular requirements of manufactured homes, where fire danger is severe.

High priority research and development over the next few years needs to focus on sprinkler systems that will create the potential to give builders realistic cost saving construction alternatives when installing sprinklers in one and two family units. Especially important are "combined systems" in which the sprinkler system and domestic water supply are merged into a single component. It will also make retrofitting far more feasible economically.

3. The performance standards, covering specifications for sprinkler installation, maintenance and inspection, have been developed.

Sprinkler standards have been promulgated by the National Fire Protection Association (NFPA) for all types of residential dwellings. The NFPA, which represents a broad cross section of the industry – firefighters, architects, engineers, insurance companies, manufacturers, code officials and equipment installers and inspectors – developed the first residential sprinkler standard in 1975 and has updated and extended its work on a regular basis since then.

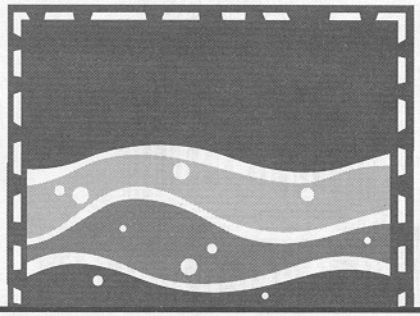
We now have a Standard (NFPA–13) for large (most commercial) buildings, Standards (NFPA–13D) for one– and two–family dwellings and manufactured homes, and NFPA–13R for residential occupancies up to and including four stories in height.

An additional standard – NFPA 25 – (which replaces NFPA–13A/14A) – was added in 1992 and covers the inspection, testing and maintenance of water–based fire protection systems, including sprinkler systems in accordance with NFPA–13. This brings the critical issue of quality control under nationally recognized standards. Periodic inspection of systems is important to insure that they perform as intended. Work continues to ensure that simplified methods of design and engineering can be brought to residential systems.

4. There are a number of water, and water–related, issues connected to sprinklers that need further resolution.

One issue relates to backflow prevention. Backflow prevention devices, which isolate the water used for sprinkler systems from that used for domestic purpose, are required in many jurisdictions. Various types of devices are available to perform this backflow function, however, in some communities the standards may be more stringent than needed to guarantee drinking water purity. This can adversely affect consumers by pushing up the cost of sprinkler system installation.

Additionally, water authorities in a number of communities around the country have adopted policies of charging fees to homeowners for the initial connection of the sprinkler system to the water supply (connection fee), and for maintaining the availability of water, should it be needed (standby charge).



The amount of the fees varies widely, and in some cases clearly constitutes a pronounced financial disincentive to sprinklers. In nearly 50 California communities surveyed in the first half of 1993, for example, the average residential connection fee is $1,646 and the average residential standby fee is $143 annually.(20)

Sprinkler proponents believe that these fees – especially the standby fees – are questionable policy. There is no charge to homeowners who have not protected their property with sprinklers for the far greater amount of water that is needed to suppress a fire once it occurs. They are working with national water supply organizations to develop a more rational approach.

5. There is increasing Congressional action, and action on the state level, in support of residential sprinklers.

Congress has passed two pieces of legislation in the past three years that puts the leadership of the Federal government to work on behalf of sprinklers. The first, the Hotel and Motel Fire Safety Act of 1990, requires workers on Federal travel to stay only in facilities equipped with smoke detectors and sprinklers that meet the applicable NFPA standards. The second, the Federal Fire Safety Act of 1992, requires the installation of sprinklers in all newly–constructed government–owned high rise buildings, in all newly–leased Federal facilities, and in all multi–family Federally–assisted housing more than four stories in height.

At the state level, there is also action, especially from the National Association of State Fire Marshals which is playing a vigorous role, in cooperation with the United States Fire Administration, to ensure implementation of both of these acts. Some states have, in fact, enacted legislation on these issues.

6. Action in communities to introduce residential sprinklers in new construction is accelerating, and is thus significantly ahead of the code organizations with respect to one and two family dwellings.

Many communities across the country are proceeding with residential fire sprinkler system requirements. Cobb County, Georgia and Napa, California have been extensively profiled – they have been joined by hundreds of other

communities. Increasing attention by building code organizations, including NFPA, demonstrate this growth in sprinkler interest. California jurisdictions appear to lead the country in residential fire sprinkler installation. In 1978 there was one community (City of San Clemente – population: 30,000) in California which had the requirement for "all newly constructed single–family dwellings to be equipped with residential fire sprinklers."

7. Home builders are offering home buyers options for residential sprinklers in new construction more frequently, as the benefits of sprinklers become better known and as incentives, in the form of construction alternatives, increase.

For the first time in 1993, there was a model house with sprinklers – the Safe and Smart Home – exhibited at the National Association of Homebuilders Annual Convention. The NAHB Research Center is presently working on demonstration projects – funded by the United States Fire Administration and conducted jointly with the International City/County Management Association – to implement construction alternatives that can bring down builders' costs for sprinklers. This project, identifying barriers to residential sprinklers and developing innovative alternatives, is an important initiative.

8. Public awareness of the benefits of sprinklers is low.

Increased public awareness is the critical next step in the drive to sprinkler America's residential housing. There are three avenues for action:

■ Highlight for all citizens the basic data about the extent to which sprinklers save lives and property. Even in advance of the code changes that will remove barriers to sprinklers nationwide, this can encourage the same consumers who demand airbags in their cars, and who spend several thousand dollars to protect their homes with electronic alarm systems, to demand homes with sprinklers. These consumers will seek to protect their families and seize an opportunity to improve their quality of life.

■ Educate the public with the facts about residential fire sprinkler technology:

Technology has created attractive, unobtrusive designs of residential fire sprinklers.

Residential fire technology has advanced reliability and responsiveness.

In experience to date, 90 percent of fires are contained with one documented sprinkler operating. Each residential fire sprinkler responds independently, resulting in fires rarely spreading beyond the room of origin.

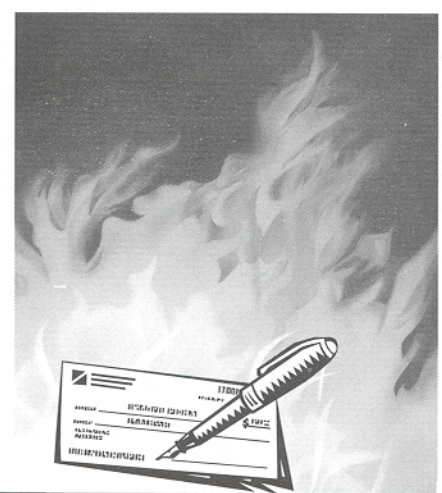
A community with sprinklers will require significantly less water for fire suppression since a residential sprinkler uses as little as 10 to 18 gallons per minute, as compared to the 150 gallons per minute needed to manually suppress a small house fire.

■ Reach opinion leaders with information that links sprinklers with several broad and increasingly accepted truths – that the country needs affordable housing; that conservation of natural resources (i.e. water) is a must; and that we must find a way to reduce demand on public sector services. Residential sprinklers fit naturally into the debate around all three of these issues. Each is basically an economic issue, and it will be economic arguments that ultimately will drive the sprinkler issue. The conclusions will be that we cannot afford not to use sprinklers, given the alternatives, and that we must find ways – largely through construction and land use incentives and action on water charges – to bring down the cost of sprinklers. A concerted effort to reach opinion leaders with these economic arguments is a priority next step.

Conclusion

Residential sprinklers have the potential to reduce fire death and property loss attributable to fire. They can do so without jeopardizing the affordability of the housing stock in this country. They can enhance the capacity of public officials to provide for the health and safety of all our citizens – including those most at risk, such as the elderly, the very young, and the disabled.

At the same time, residential sprinklers can help to flatten future expenditures for fire – without diminishing the quality of fire service and protection. This is vital in a time of distressed public sector budgets.



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